Cooperative NOAA/NASA Altair Missions

Channel Islands and Eastern Pacific April to November 2005

The Altair UAS, developed by General Atomics Aeronautical Systems, carried a payload of NOAA-developed instruments and other scientific equipment up to 45,000 feet. The longest duration flight was 18.4 hours. Original flight objectives included sampling low-level jets in the eastern Pacific Ocean that bring moisture to the continental US; sampling regions of high-potential vorticity at midlatitudes that result from transport of polar air; measuring greenhouse gases; imaging of the Channel Islands National Marine Sanctuary (Fig. 2) to examine shorelines, surveying marine mammals, and evaluating the potential for marine enforcement surveillance.

Fig. 2. Altair on Channel Islands flight

The scientific instrument package onboard the Altair flights included an *in situ* gas chromatograph to detect SF_6, N_20, CFC-11, CFC-12, and halon-1211; an *in situ* ultraviolet absorption instrument to detect ozone; a remote ocean color instrument with 7-band optical radiance detection to measure chlorophyll-a; and a remote Passive Microwave Vertical Sounder which measures temperature, moisture, and cloud parameters with a microwave and infrared sensor suite. Operational instruments on Altair included a Digital Camera System with a nadir-view, high-resolution, true-color digital camera and an Electro-Optical/Infrared Sensor (EO/IR) for surface mapping and monitoring; also NASA's Research Environment for Vehicle-Embedded Analysis on Linux (REVEAL), a flexible aircraft systems interface with satellite connectivity to handle GPS, aircraft and instrument payload parameters.

Fire Mission Summer 2006

The purpose of the NASA/USDA-FS Fire Mission is to conduct a UAS trial to sense active forest fires remotely from high altitudes and locate hot spots for fire fighters to extinguish on the ground. There may be four to five 20-hour flights in the western United States during the peak of fire season. The flight area includes California, Oregon, and Washington states to as far east as western Colorado, and between the Canadian and Mexican borders.

Fig. 3. Artist's rendition of Altair on the Fire Mission flights.

The Argus instrument from NASA Ames Research Center will provide carbon monoxide measurements at 0.5 Hz for a maximum of 18 hours during the flight. REVEAL (NASA DFRC) will provide a data link for the UAS Chromatograph for Atmospheric Trace Species (UCATS) instrument and ground presence of the Altair aircraft. The NOAA/ESRL/GMD UCATS instrument will provide the following:

- Ambient air temperature (-70 C – 40 C) to 0.1 C accuracy and relative humidity measurements (0-100%) once every 8 sec using Vaisala series HMT 337 probe
- Water vapor sampled once a second with a Maycomm Tunable Diode Spectrometer
- Tropospheric (0-200 ppb) and stratospheric ozone (O_3) measurements (>200 ppb -10 ppm) once every 10 seconds using 2B, Inc Ozone photometer
- Atmospheric nitrous oxide (N_2O) and sulfur hexafluoride (SF_6) once every 70 seconds using custom gas chromatograph (GC) with electron capture detection (ECD)
- Atmospheric hydrogen (H_2), methane (CH_4), and carbon monoxide (CO) measurement once every 140 seconds using custom GC-ECD

Aerosonde Missions:

Tropical Storm Ophelia (September 2005)

This mission used a smaller 33-pound, 10-foot wingspan Aerosonde UAS with to show the potential benefit of using a UAS to obtain critical, previously unobtainable hurricane data. NOAA's partners in this effort included AAI Corp. (formerly Aerosonde, Inc.), who acted as the system's operator, and NASA Goddard's Wallops Flight Facility. Instrumentation on the Aerosonde included mounted GPS drop-windsondes and a satellite communications system that

Fig. 4. Aerosonde in Tropical Storm Ophelia

relayed information on temperature, pressure, humidity, and wind speed every half-second in real time to ground users; and a downward-positioned infrared sensor used to estimate the underlying sea surface

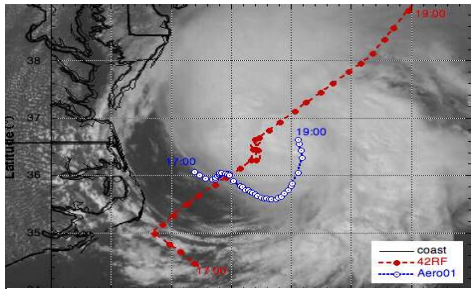

Fig. 5. Closest approach of Aerosonde to the center of Tropical Storm Ophelia

temperature. All available data were transmitted in near real time to NOAA's National Hurricane Center.

Key West Naval Base (September 2006)

The demonstration project is scheduled to run for thirty days, from September 1-30, 2006, in cooperation with Aerosonde Corp., NASA, and the U.S. Navy. The Aerosondes will be deployed at Key West Naval Air Station (NASKW), and will have an approximate 300 nautical mile operational radius from the deployment base. Single or multiple Aerosonde experiments will be coordinated with NOAA and AFRES aircraft missions during the 2006 demo. The following experiments are possible:

- Sampling the tropical cyclone inflow layer's structure by flying within 500 feet of the surface in the inner core, spiraling in on the winds of the storm
- Flying a fixed radius orbit in order to improve the radial accuracy of the wind estimates
- Flying a corkscrew sounding within the eye up to 10,000 feet, to find any early detection signal of rapid intensity changes

NASA Dryden Flight Research Center

A NOAA partner, NASA Dryden Flight Research Center, located on Edwards Air Force Base is a leading flight research and test organization with the capability and commitment to provide direct support to NASA and non-NASA customers worldwide. With unparalleled talent**;** extensive infrastructure**;** and a commitment to safety, teamwork**,** and customer satisfaction, Dryden develops and validates high-risk, pioneering aerospace technology, and conducts science missions with unmanned and manned aircraft.

Dryden is expanding its reach into the aerospace community by offering new and improved flight test services with HALE Global Hawk and Ikhana (Predator B) UAS through its ***UAS Service Center*** (UASSC) to meet a variety of requirements such as subsystem development, integration of UAS into civil airspace; and flight support for science, security, and commercial applications. In particular, DFRC is working closely with NOAA to provide UASSC support for high-priority missions such as Global Climate Change and disaster monitoring (e.g., hurricanes, fires, floods, and earthquakes).

A range capability is also available for smaller low-altitude UAS testing on the Edwards range within the confines of restricted airspace to provide cost-effective**,** streamlined access to services without the need for COAs or experimental certificates.

Contacts

For more information on the NOAA UAS Program, contact Sara Summers at sara.summers@noaa.gov or (303) 497-4221; or http://uas.noaa.gov

For more information on NASA's DFRC UAS Service Center, contact Yvonne Kellogg at yvonne.kellogg@dfrc.nasa.gov or (661) 276-3720.

Unmanned Aircraft Systems

Improved data and observations hold the key to saving lives, property, and resources. The Global Earth Observation System of Systems (GEOSS) international effort aims to link the existing global network of sensors and observations to give us an unprecedented tool for understanding how Earth's systems interact. To provide truly comprehensive coverage, however, the void between satellites and ground-based sensors will have to be filled. Unmanned Aircraft Systems (UAS) have the potential to fill this void.

NOAA and NASA are partnering with DOE and industry to seek ways to make UAS operational in order to achieve the goals of GEOSS and respective Agency priorities. These include hurricane tracking and intensity forecasts, long-term climate monitoring and prediction, satellite calibration and validation, fisheries enforcement, etc. Several NASA Centers are actively involved with NOAA science missions. In particular, Dryden's new UAS Service Center (UASSC) will soon be offering high-altitude, long-endurance (HALE)-class UAS for a variety of new NOAA missions.

Fig. 1. Artist's rendition of Global Hawk (built by Northrup Grumman) over Hurricane Elena (1985).